HETCH HETCHY Water Magic

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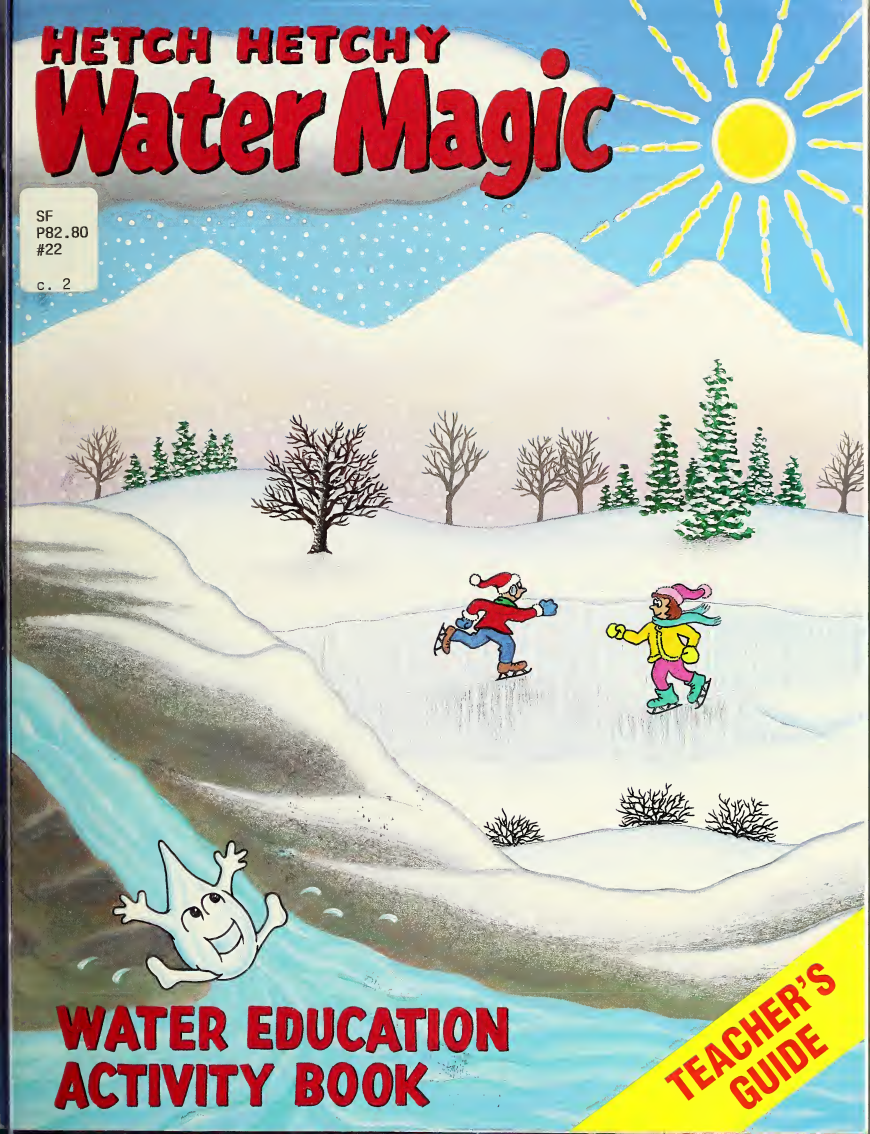

WATER EDUCATION ACTIVITY BOOK

TEACHER'S GUIDE

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Note to Teachers

Water Magic was developed for grades 3-5 by the San Francisco Water Department and the Bay Area Water Users Association (BAWUA), with help from the San Francisco Department of Public Work's Bureau of Environmental Regulation. The main focus is on helping students learn about the world around them and the vital role that water plays in their lives. Special emphasis is placed on conservation efforts and ways each individual can act to ensure the preservation of our precious water supply.

The lessons are intended to stimulate discussion and motivate students to express their unique creativity as they arrive at practical solutions to using water wisely. Small group participation is an integral part of these lessons.

Introduction to Lessons

The *California Education Code's #8702* states that our system of education must "build necessary attitudes of stewardship toward the maintenance of the quality of our common environment, and enable all citizens to use wisely, and not destructively, the resources at their disposal." The *1990 Science Framework* promotes thematic teaching in combination with active learning. An interdisciplinary approach to teaching conservation is strongly urged.

Water Magic was created with an underlying philosophy of interdisciplinary learning, using an experiential approach. These twelve lessons are activities which integrate learning objectives in science, math, social science, language arts, art and music. Each lesson refers to the thematic science concept, outlined in the *Science Framework for California Public Schools, Kindergarten through Grade Twelve* (California Department of Education, Sacramento, 1990). The student workbook is designed for grades 3-5. Most lessons can usually be completed in 30 to 45 minutes. Some may require more or less time, depending on pace of instruction, class ability and student interest.

The Teacher Guide for *Water Magic* contains a variety of enrichment exercises to expand the scope of the lessons in *Water Magic*. Each lesson in the Teachers' Guide includes background information. Lessons need not be taught in sequential order, and teachers are encouraged to choose and adapt those which are most appropriate for their own classrooms.

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Lesson 1 — The Magic of Water

OBJECTIVE: Students compare the amount of ocean water to the amount of fresh water on the planet.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, page 2

MATERIALS:
- World globe
- One paper plate per student
- One pair of scissors for every 2-3 students
- Crayons for each student

FRAMEWORK: Physical Science A-1, A-3, B-2. Earth Science C-1

BACKGROUND: Approximately 97% of the earth's water is found in oceans. Only 3% of the earth's water is fresh water. Approximately 1% is in lakes, rivers and groundwater and can be used for drinking. The other 2% is frozen in glaciers and icebergs at the North and South Poles. You may have to remind students that they can't drink salt water.

Almost every city relies on fresh water for its water source. But some areas rely on ocean water for their water source with desalinization plants that remove the salt from ocean water. There are several desalinization plants in various locations such as Florida and Saudi Arabia. The Naval Base at Guantanamo Bay, Cuba relies on a desalinization plant for all of its water. But the cost of fuel makes desalinization of water prohibitive for most places. One process of desalinization is that the ocean water is boiled to a vapor or steam. Since the salt is heavier than the water, the salt stays in the pot or container. The steam or vapor is caught in a separate cylinder. The condensation from the vapor then creates the fresh water.

We rely on the water cycle for our fresh water. Water is circulated throughout the planet via precipitation. Precipitation comes from water vapor that condenses in clouds. Depending on the weather conditions, precipitation comes in the forms of rain, snow, sleet or hail. It provides the land areas with their source of fresh water, which plants, people and animals need to live. Water may be collected in rivers, lakes or reservoirs, or steeped into the ground and become a part of the aquifers which may be tapped by wells. It also may fall onto oceans or rivers that empty into the sea.

ACTIVITY:
1. Spin a globe and ask the student what color almost completely covers the globe? (Blue) What does that color indicate? (Approximately 80% of the earth's surface is covered with water.)

2. To reinforce the concept of earth as a water planet, give each student a paper plate and crayons.

3. Have students cut their plates into 4 equal parts. They can color 3 parts blue and 1 part brown or green to represent that 3/4 of the earth is covered with water and 1/4 is covered by land.

4. If there is time, students can draw all of the people, plants and buildings that they know on the land section. They can draw all of the marine life and fish that they know about in the sections that are covered in blue.

DISCUSSION QUESTIONS:
1. How does ocean water differ from the water that we get out of our faucets? (Students may say that the ocean water has salt; ocean water supports fish and marine life, and it is easier to float in ocean water.) Why are marine animals and fish able to drink and use salt water? (Saltwater fish's gills and kidneys eliminate salt. In fact, their kidneys eliminate less water [urine] than freshwater fish.)

2. The same amount of water that was on the earth when the dinosaurs walked is the same amount of water that we have now. Even though the amount of water has stayed the same, do you think people are using less or more water than they used 50 years ago? (In most cities throughout the United States, people living in the 1990's are using more water than those living in the 1940's. This is primarily due to the introduction and acceptance of clothes washers, dishwashers and other appliances.)

VOCABULARY: Solid, Liquid, Gas, Puddle, Rain, Ocean, Globe, Lake, Desalinization

Lesson 2 — States of Water

OBJECTIVE: Students will comprehend the three states of water and comprehend the scarcity of fresh water on the planet.

TIME: 2 class periods

RESOURCE: *Hetch Hetchy's Water Magic*, Page 2

MATERIALS:
- One overhead projector
- One eye dropper
- 8 oz. of ice
- One clear plate
- Freshly cut grass
- Sandwich bags

FRAMEWORK: Earth Science C-1. Physical Science A-3, B-1, B-2.

BACKGROUND: All matter is classified as solid, liquid or gas. All matter, including air, has weight (mass) and occupies space (volume). Water is an unusual substance. It exists in all three forms. If it is frozen or solid, it can be an ice cube, snowflake, hail or snow. When it is at room temperature, it is liquid. When it is heated, it becomes vapor or steam, or evaporates as an invisible gas.

Molecules in most substances move faster and farther apart when that substance is heated. Molecules contract or move more slowly and closer together when the substance is cooled. Water is unusual because it does not contract when it is cooled. It is the only substance that expands when it is frozen. This is very important. When a lake or river freezes, it rarely freezes down to a depth of more than a few feet. This allows liquid water to run under the ice and allows fish to survive in the winter. Ice is less dense than "liquid water," so it floats on liquid water underneath.

In this experiment, students capture the evapo-transpiration of the grass. The sun or the overhead projector's lamp acts as the heat source to cause the moisture in the grass to become water vapor. After thirty minutes, the moisture spots in the bag are the accumulation of the precipitation that has resulted from the moisture in the grass clippings.

ACTIVITY:

A. Demonstrate the water cycle to students.
   1. Give each child a self-sealing sandwich bag.
   2. Have each student put a handful of freshly-cut or pulled grass into the bag. Have students seal the bag.
   3. If possible, put the sandwich bags in a sunny spot. Some suggested locations would be a window sill or under a overhead projector's light.

DISCUSSION QUESTIONS:

1. How are the front and back covers of *Hetch Hetchy's Water Magic* different from each other? (Students might notice on the front cover that the lake is frozen and the children are wearing winter clothes. Students might notice that on the back cover, the children are wearing swimsuits and the sun is out.) Which cover shows the students in cold weather? (The front portrays winter and the back portrays summer.)

2. On page 3 of the student booklet, the water cycle is illustrated. What role does the sun have in the water cycle? (Its heat evaporates the water into water vapor.) What role do the clouds play in the water cycle? (The clouds are water vapor that is attached to pieces of dust. When the temperature changes and becomes colder, the water vapor falls down as rain or snow.) What role does precipitation play in the water cycle? (Precipitation as rain or snow falls down. Some of the precipitation accumulates and replenishes lakes, rivers and reservoirs, which are supplies for drinking water.)

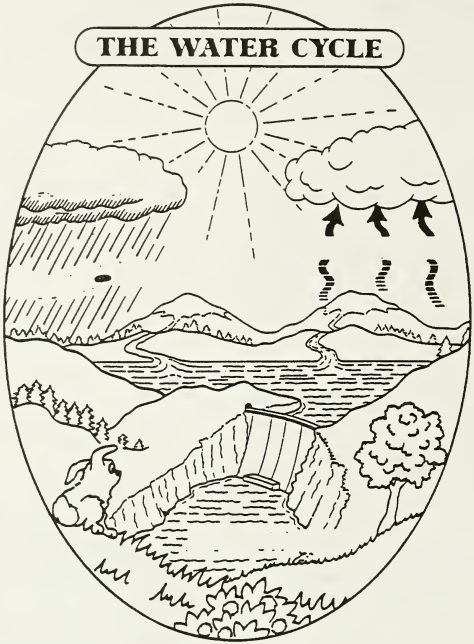
3. Where have you seen steam or water vapor? (Students may mention fog, steam from manhole covers or from tea kettles.) What season is the fog heaviest in San Francisco? (Most of the fog comes in during the summer months.) Why? (The warm inland air meets the cold air above the Pacific Ocean at the coast. The combination of the dry warm air and cold wet air creates fog.)

VOCABULARY: Condensation, Evaporation, Precipitation, Accumulation, Groundwater, Water Cycle

Lesson 2
Activity Worksheet

States of Water

Name: _____ Date: _____



Label the following components of this water cycle and draw in the arrows that show the process.

Accumulation	Lake
Precipitation	Sun
Evaporation	River
	Cloud

Hetch Hetchy Reservoir

What is Hetch Hetchy? Why is it important?
Hetch Hetchy is the name of the largest reservoir in a system that provides most water to San Francisco and the surrounding suburbs. Since the reservoir is the largest element in the water system, many people refer to the entire 148-mile water system as "Hetch Hetchy."

The name comes from a Miwok Indian word for seeds of grasses that were used for food. Hetch Hetchy grasses were plentiful in the Hetch Hetchy Valley. The floor of the valley is now the bottom of the Hetch Hetchy Reservoir. It provides water for people in San Francisco, Alameda, Santa Clara and San Mateo counties.

In the early 1900's, San Francisco's leaders began looking for a location where they could collect and gradually release water from rivers and melting snows. They located the perfect spot at the Tuolumne River near Yosemite National Park.

The San Francisco Water Department (SFWD) finally got permission in 1912 to build three reservoirs in and near Hetch Hetchy Valley. These reservoirs are Hetch Hetchy, Lake Lloyd and Lake Eleanor. To build the reservoirs, the SFWD had to construct three power houses and three major pipelines to carry water to Bay Area homes and businesses. Engineers also constructed five reservoirs close to San Francisco and two filter plants. Three large pipelines carry water 148 miles to the San Francisco Bay Area.

Construction took 20 years
The work had to be done in different stages. First, a roadbed was cut leading to the 3,500 foot high site. Steep rock walls made the Hetch Hetchy Valley difficult to reach by car. Mule teams helped deliver supplies, machinery and construction materials. Only horse-drawn vehicles could get through deep mud in spring. In winter, the area was cut off by heavy snows. Building a railroad was the answer. Slowly, the 68-mile Hetch Hetchy Railroad took shape. Trains helped to get men and materials into wild, mountain areas.

Workers built powerhouses downstream to generate electricity for the construction work. Electricity could also be sold to help pay for the project. Lake Eleanor was built first, providing water year-round to produce electrical power.

The most challenging work was building the main reservoir, Hetch Hetchy. Workmen drilled and blasted a hole 118 feet deep into the valley floor for the dam's foundation. The walls became even steeper, making work more difficult. The railroad became increasingly important. For example, over 5,000 boxcar loads of cement were used for building the dam. Many trees were also cut before the valley floor could be flooded. Sawmills were built to cut the trees into boards. Lumber was used to construct work camps. Trains also hauled logs away to be sold for firewood.

For two years, 500 city workers labored in blazing summers and freezing winters. Crews often worked all night under bright floodlights. Water was finally delivered to San Francisco from the Hetch Hetchy system on October 24, 1934.

Hetch Hetchy Today

Today the 312-foot high dam is more important than ever. Hetch Hetchy water is expected to provide local water needs beyond the year 2010. The granite reservoir walls and the dam's sheltered site help to keep the water pure. All water is carried in a closed system of pipes and aqueducts, keeping it clean. At each step, water is checked for quality by the San Francisco Water Department.

Water is treated at the Sunol Valley Water Treatment Plant. At the reservoir, raw water is passed through intake screens to remove leaves, sticks, fish and other large debris. At the treatment plant, chlorine is added to kill most disease-causing organisms. Chemicals are added which cause very fine particles to clump together into larger particles. Mixers are used to help the larger particles form particles that can settle or be filtered. The water then enters a sedimentation basin, something like a very long and narrow swimming pool. Most of the floc (flocculant) settles out in the sedimentation basin. The remaining floc is removed by filters. Filters are large concrete basins which contain layers of gravel, sand and charcoal. Filters remove almost all of the particles larger than one micron (approximately one-hundredth the width of a hair). Some chlorine is added to the water after it is filtered to maintain a protective residual in the water coming out of your taps at home. Sodium hydroxide is added to minimize pipeline corrosion. Fluoride is added along our transmission pipelines to protect against cavities.

Lesson 3 — Water for San Francisco

OBJECTIVE: Students learn how water comes to San Francisco by making a topographical map of northern California.

TIME: 2 class periods

RESOURCE: *Hetch Hetchy's Water Magic,* page 4

MATERIALS:
- Map of San Francisco's water system in packet
- Map of California's water resources in packet
- Map of the State of California in packet
- One ruler per four students
- 4 pounds of clay in packet
- One brown grocery bag
- One roll of wax paper in packet
- One 8' by 4' table—teacher to supply

FRAMEWORK: Physical Science C-2

BACKGROUND: To deliver water to its 2.6 million customers in San Francisco, San Mateo, Santa Clara and Alameda counties, San Francisco has created a water system that begins at the Hetch Hetchy Valley in Yosemite National Park. Hetch Hetchy Valley is 148 miles from San Francisco. Because the Hetch Hetchy Reservoir is in the Sierra Mountains, the water flows downhill by **gravity**. This is an enormous engineering feat, which required much drilling and boring of tunnels to avoid having to pump the water up over mountains. Pumping uses a great deal of fuel and energy.

ACTIVITY:
1. Cut the grocery bag, so that it lies flat in one sheet on the table.

2. Draw an outline of the State of California.

3. Have students cover the outline with the clay.

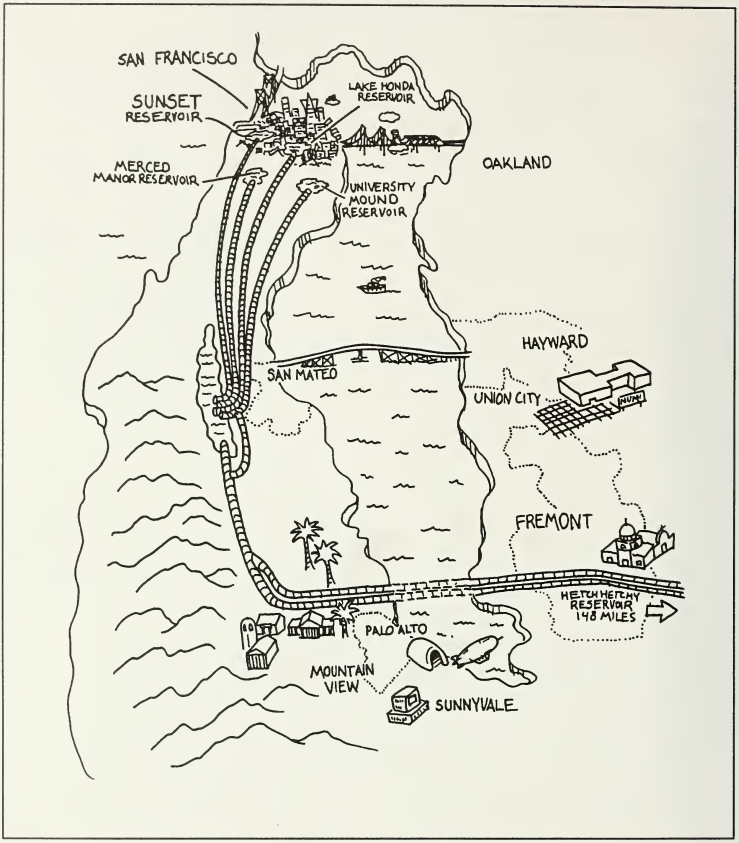
4. Then using the California water resources map, have students create a topographical map of California or Northern California (from the Yosemite Park up). With the clay, create mounds for the mountains and indentations for valleys and peaks for mountains. The map should include:
   - Sierra Nevada Mountains
   - Mount Shasta
   - Inland plains
   - American and Sacramento rivers
   - Death Valley
   - Ocean
   - San Francisco Bay
   - Mount Whitney

DISCUSSION QUESTIONS:
1. What is the highest point in California? (Mount Whitney is the highest point in California.) What is the lowest point in California and the continental United States? (There is a point in Death Valley, where the elevation is 220 feet below sea level. This is the lowest point in both California and the continental United States.)

2. Are there any differences in rainfall or precipitation levels between areas in the mountains and areas in the desert? (Yes, there is very little rain in the desert. In the mountains, there is a great deal of rain and snow. The reason is that warm air rises and meets the cold air. If there is moisture in the warm air, the mixture of cold air can cause rain. In the desert, there aren't any large bodies of water to add moisture to the air. So the weather is extremely dry in the desert.)

3. Is there a lake or river near San Francisco? (The largest lake near or in San Francisco is Lake Merced. Lake Merced is an emergency supply for drinking water. Point Lobos Creek is the largest creek in San Francisco. It supplies water to the Presidio.) Which area of the state have the largest number of lakes or rivers? (The area surrounding the Sierra Nevada Mountains has the largest number of lakes and rivers.)

Lesson 3 — Water for San Francisco



Lesson 3
Activity Worksheet

Finding Water for San Francisco

Name: _____ **Date:** _____

1. With the map of the state of California, find the distance between these locations.

Location #1	Location #2	Distance Between Locations
Sacramento	Los Angeles	
San Francisco	San Jose	
Daly City	Los Angeles	
Palo Alto	Fremont	

2. Using the **California Water Resources Map,** measure the distance between these locations. *Bonus Question:* How does each dam or aqueduct relate to its corresponding city:

Dam or Aqueduct	City	Distance Between Locations
Shasta Dam	San Diego	
Mono Lake	Los Angeles	
Oroville Dam	San Jose	
Beginning of Mokelumne Aqueduct	Oakland	

3. Have one group measure the distance of the following locations in the table below on the **San Francisco Water System Map:**

Location #1	Cities on SFWD System	Distance Between Locations
Hetch Hetchy Reservoir	San Francisco	
Lake Eleanor	Hayward	
Cherry Dam	Belmont	
Tesla Portal	Union City	

Lesson 4 — How Dams Help Us

OBJECTIVE: Students simulate the force of water and show how it can be used to generate electricity.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, page 5

MATERIALS:
- Two water guns
- Wash tub
- Two pin wheels
- 4 ounces of clay
- Paper towels

FRAMEWORK: Physical Sciences C-2, C-3

BACKGROUND: Dams hold the water back in a reservoir. Water then goes through an "outlet" and follows the river on the other side of the dam. Water dropping down the outlet is pushed by the force of the remaining water in the reservoir. As water drops down, the force of the gravity can be used to turn a wheel. This is why dams are used in generating electricity or in grinding wheat or meal in mills. The stream of water has so much energy and force. The combined power in this stream can be used to push turbines in hydroelectric plants and grindstones in mills to grind wheat, as well as other tasks on its way to get downriver.

In this way, dams hold water at high elevations, which can then run machines.

ACTIVITY:
1. Announce to the class that they are going to participate in a race. The rules are that each student will try to get the pin wheel to turn as many times as they can in one minute.

2. Put each of the pinwheels in the tub and anchor the pinwheels with clay at each base.

3. Fill each of the water guns with the water.

4. Have the students in groups of two try to propel a pinwheel with water from the watergun. Have two other students count the number of times each student gets the pinwheel to turn.

DISCUSSION QUESTIONS:
1. Which student made the pinwheel go around the largest number of times? Where did the student place the force of water on the pinwheel? (If the stream of water is placed directly on the tips of the pinwheel, the pinwheel moves much faster.)

2. Did it make a difference in getting the pinwheel to go around, if the student was shooting from one foot away rather than from three feet away? (Depending on the water gun, it usually is easier to get the pinwheel to move if the student and the water gun are directly above the pinwheel. This allows the flow of the water to use the gravitational pull of the water to push the pinwheel at greater force.)

3. Humans aren't the only ones that use water stored in dams. Why do beavers build dams? (Beavers build dams to create a pool to trap fish. Beavers eat fish for food.) Do other wildlife use the beavers' dams? (Yes, a few examples of wildlife using the environment surrounding a beaver's dam, are ducks and trees. Ducks like to swim in the calm ponds created by the beavers' dams. Trees are more likely to become established at the banks of a pond rather than a river, since they have a constant source for water.)

EXTENSIONS:
- You can show the video "Hetch Hetchy and You." For LEP students, lower the volume and show only portions of the program which feature construction and footage of Hetch Hetchy.

VOCABULARY: Dam, Reservoir, Pipeline, Sierra Nevada, Mountain, Gravity, Tuolumne River, Yosemite National Park

Lesson 5 — Eco-System of a River

OBJECTIVE: Students learn how the quality of their water and the eco-system surrounding a river are dependent on one another.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, pg. 5

MATERIALS:
- One empty lunch-size milk carton per student (carefully washed out)
- Black felt pen
- Table surface

FRAMEWORK: Life Sciences C-1

BACKGROUND: The eco-system of a river is a fragile one. Inside a healthy river, there is a great deal of life. Micro-organisms, such as whiteflies, stoneflies and other insects, are the "canaries" of the river. If the river is contaminated by pollution (either the waste of animals or humans), these insects living in and on the river die, and so do the fish that eat the micro-organisms.

To survive, these insects need plants, sunlight and rapid running water. The plants provide them with fuel, sunlight provides them with warmth, and the rapid running water provides them with a great deal of oxygen. Groups such as the Izaak Walton League's Save Our Streams, monitor the health of the river by measuring the amount of micro-organisms that they can find within a one-foot by one-foot area of the river. They take a drop net to capture the insects that are flowing down the current of the river within a set period of time (usually 15 seconds to one minute). They then count the number of different micro-organisms that they capture in the net. The healthiest rivers have a wide variety and a large number of micro-organisms, which in turn keep a large variety of fish and wildlife alive in the river. Once counted, the micro-organisms are released back into the river and the river's ecosystem.

ACTIVITY:

1. Have students choose one of the following things to have their milk carton represent as part of the eco-system of a river. They should write the name or draw a picture to represent one of the following:

   Fish
   Raccoon
   Insect
   Bird
   Plant

2. Break students into five separate groups each corresponding to the animal, insect or plant they have chosen to have their carton represent.

3. Count the number of students who choose to have their cartons represent plants. Have students place the carton down on the counter with the cartons on their sides. Plants represent the bottom of a river's food chain. Without plants, the eco-system of the river can not support any type of life.

4. Have students who choose to have their cartons represent insects, put their insect cartons on top of the plant cartons. There should be a ratio of one plant carton to every insect carton. If there is not a one-to-one ratio of insect cartons to plant cartons, then some of the insect cartons need to be eliminated. Insects need plants to eat, and if they don't have plants to eat, then they die. So the extra insect cartons have to be taken out of the game. If there are more plant cartoons than insect cartons, then none of the cartons have to be eliminated. An abundance of plants leads to a stable food supply for the fish and the result is usually a larger insect population.

5. Have students who choose to have their cartons represent fish, put their fish carton on every fifth insect carton. If there are not at least five insect cartons to every fish carton, then the extra fish cartons have to be eliminated. Fish need insects to eat, and if they don't have enough insects to eat, then they die or swim to another area of the river. If there are more than five insect cartons per fish carton, then none of the cartons have to be eliminated. Abundance of insects leads to a stable food supply for fish and the result is usually a larger fish population.

6. Have students who choose to have their cartons represent raccoons, put their carton on every second fish carton. If there are not at least two fish cartons to every raccoon carton, then the extra raccoon cartons have to be eliminated. Raccoons eat fish, and if they don't have enough fish to eat, they will move to find an area that has more food or fish. If there are more than two fish per raccoon carton, then none of the cartons have to be eliminated from the game. Abundance of insects leads to a stable food supply of fish for the raccoons and the result is usually a larger raccoon population or a wider diversity of different animals that eat fish living near or on the river.

Lesson 5 — Eco-System of a River (continued)

7. Birds occupy several important positions in the food chain. Birds eat insects as well as parts of certain plants, but they also drop seeds in their droppings which cause more plants to grow. The bird cartons then need to circle the entire pile of the plant, insect, fish and raccoon cartons.

DISCUSSION QUESTIONS:

1. What do you think would happen to the fish and raccoons if someone killed all of the insects with bug spray (insecticide)? (The fish would eat the dead bugs and could then die from the poison that killed the insects. The raccoons could eat the sick fish and die from the poison inside the fish.)

2. What would happen if there were too many plants in the river? (The plants would slow down the velocity of the water and make the river muddy. The faster the river moves, the more air it mixes with. Fish need a oxygen to stay alive. Trophy fish like trout and salmon need a high oxygen content to stay alive.)

Lesson 6 — How Tanks Help Us

OBJECTIVE: Students learn how water is distributed throughout the city of San Francisco.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, page 5

MATERIALS:
- Map of San Francisco's distribution system in packet
- Two 8 oz. paper cups, in packet, per pair of students
- One cup of water per pair
- Ten paper towels per pair—in packet
- One pencil per student
- Two 3" long pieces of masking tape per pair—in packet
- One ruler per pair

FRAMEWORK: Physical Sciences C-2, C-3

BACKGROUND: San Francisco is a city of hills. From Mt. Sutro to Lombard Street, San Francisco has an abundance of hills and valleys. Unfortunately, water does not naturally run uphill. In order to assure that everyone has water whenever they turn on their faucets, the San Francisco Water Department has many elevated water tanks and reservoirs throughout the city. This allows the natural force of gravity to distribute the water throughout the city. Without pressure, water wouldn't have the necessary "push" to get to the high points of San Francisco and come out of your faucet. Pressure also protects water by pushing anything away that might enter into the pipe and contaminate the water.

The pressure of water remaining in an elevated water tank pushes the water out at the bottom of the tank. The elevation of the tanks keep water at a steady pressure. So when water enters a home, it is under pressure. When water is "under pressure" or pressurized, it will flow out of a faucet at a steady rate. If the faucet is not "under pressure" or is not pressurized, it will dribble out of a faucet. The average pressure of a home in San Francisco is 35-80 pounds psi (per square inch).

ACTIVITY:
1. Break the class up into teams of two.

2. Tell students to use their pencils to punch one hole from the top of one of their cups and another hole one inch directly below the other hole. Cover the holes with masking tape. Place the cup on the side of a desk with the holes facing out and fill the cup with water.

3. Put several towels on the floor in front of the full cup. Then have one student carefully remove the tape from both holes simultaneously. Have one student try to catch water from both streams with the two remaining cups. The other student can measure both "streams" with a ruler and note the measurements on a piece of a paper.

4. You may want to try this again with liter bottles and have pans to catch the water.

DISCUSSION QUESTIONS:
1. Did the lower or upper stream travel farthest? (The lower stream should have traveled farthest.) Why? (Because there is more water—and more water pressure—above the lower hole than the higher hole. Since the higher hole does not have as much water pushing above it, it has less pressure and forms a shorter stream.)

2. In apartment buildings that have a water tank, who do you think gets better water pressure-those on the top floors or those on the bottom floors? (In apartment buildings that have water tanks, the apartments on the lower floors have better water pressure. Again, the water in the tank pushes the water below it.)

3. In apartment buildings that have water pipes that come into the basement and then the pipes go up to the top floors, who do you think gets better water pressure—those on the bottom floors or those on the top floors? (In tall apartment buildings without water tanks, the apartments on the bottom floor get better water pressure. If water comes in from the basement and then has to move up, it is fighting against gravitational pull.)

VOCABULARY: Pressure, Apartment, Tank, Faucets

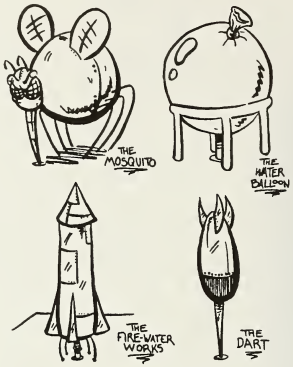
Lesson 6
Activity Worksheet

How Tanks Help Us

Name: _____ **Date:** _____

Many skyscrapers rely on a water tank to deliver water to its residents or workers. Design a skyscraper and create a water tower for the skyscraper. Be sure to design it so the tank won't fall off during a windy day or an earthquake tremor. Be sure to make it interesting since it will be an important part of your building.

Draw your skyscraper and water tower here:



Lesson 7 — Counting on Nature

OBJECTIVES: Students learn about reservoirs and different water systems throughout California.

TIME: 1–2 class periods

RESOURCE: *Hetch Hetchy's Water Magic*, Page 8

MATERIALS:
- California water resources map in packet
- Map of Hetch Hetchy system in packet
- Map of San Francisco's distribution system
- 35 large dot stickers in packet

FRAMEWORK: Life Science C-3

BACKGROUND: The Native Americans who were the first inhabitants of California, primarily lived along the coast. They were able to catch the abundant fish and marine life for their food and use nearby springs for their water source. They used water for cooking and cleaning. When the Spanish came to California, they settled near springs, rivers and lakes. This allowed them to have easy access to water.

When San Francisco was a frontier outpost, the prime locations for housing and commercial buildings were near sources of water. Then as the city grew (with the gold rush), vendors would sell bottles of water from carts.

Many newcomers and tourists enjoy California's weather because they could enjoy warm weather throughout the year. Even though San Francisco enjoys temperate climates, it only receives 20 inches of precipitation in an average year. So as its population grew, the city needed to look elsewhere for its source of water. The same problem arose in Los Angeles. Even though it is the most populated city in the state, Los Angeles' annual precipitation rate is only 13 inches per year.

ACTIVITY:

1. Have the students locate San Francisco, Los Angeles and San Diego on the California State Map and California Water Resources Map.

2. Have the students locate the following items near these cities and mark these locations with large dot stickers:
   - The widest natural river
   - The largest lake
   - The average precipitation rate for these cities
   - The number of people living in the cities

4. Have the students locate the following water systems on the California Water Resources Map:

   - State Water Project (Run by the California Department of Water Resources. Santa Clara Valley Water District, and Metropolitan Water District of Southern California are several of their customers.)

   - Central Valley Water Project (Run by the Bureau of Reclamation—Santa Clara Valley Water District and Contra Costa Water District are two of its customers.)

   - Los Angeles Aqueduct (Los Angeles Department of Water and Power)

   - Mokelumne Aqueduct (the East Bay Municipal Utility District—which serves the most of the population in Alameda County as well as a portion of Contra Costa County—owns this aqueduct.)

   - Hetch Hetchy Water System (San Francisco, Fremont, Union City, Daly City, Hayward and Palo Alto are some of its customers.)

DISCUSSION QUESTIONS:
All of the state's water systems rely on reservoirs. The student booklet on page 8 of *Hetch Hetchy's Water Magic*, illustrates the type of activities that people can enjoy on a drinking water reservoir. Using the picture on page 8 as the springboard, ask students the following questions:

1. What kind of body of water is pictured here? *(lake, reservoir)*

2. What kinds of activities can people enjoy at a reservoir? *(fishing, motorboating, rowing, camping, exploring the reservoir on a paved trail, swimming with a flotation device, etc.)*

3. What functions do dams serve? *(water storage, flood prevention, scenic beauty, recreation)*

4. What activities are permitted at most reservoirs? *(hiking, jogging, biking on the trail, walking dogs on a leash, etc.)*

5. Do we drink water straight out of a reservoir? *(No, water needs to be disinfected before it goes to a home, school or business.)*

VOCABULARY: Camping, Trail, Boats, Ducks, Pier

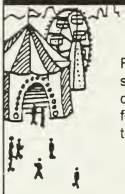
Lesson 7
Activity Worksheet

Counting on Nature

Name: _____ **Date:** _____

Listed below are six locations where activities that use a lot of water, take place. For each of these locations, circle ways that use water.

A Theme Park

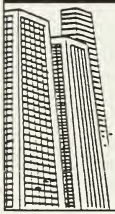


Restrooms, drinking fountains, swimming pools, water slides, decorative fountains, cleaning, food preparation, landscape maintenance, etc.

A Restaurant

Food preparation, dishwashing, drinking water, cleaning, laundering of tablecloths, uniforms, heating, air conditioning, etc.

A Group of Tall Office Buildings Downtown



Restrooms, drinking fountains, window washing, cleaning, heating, air conditioning, cafeteria, food preparation, dishwashing, etc.

A Hospital

Laundering sheets, pillowcases, blankets, uniforms of doctors and nurses, restrooms, showers and scrub rooms, cleaning, sterilizing, kitchen food preparation, cleaning, etc.

A School

Restrooms, drinking fountains, gym showers, playground maintenance, landscaping, cafeteria, cleaning, washing windows, etc.

A New Car Dealership

Restrooms, cleaning cars and showrooms, repair bays, showers for employees, drinking fountains, etc.

Lesson 8 — The Wonders of Water

OBJECTIVES: Students explore the wide-ranging forms of water in nature and better acquaint themselves with the rhythms of poetry.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, page 9

MATERIALS:
- Piece of paper for each student
- Pen for each student

FRAMEWORK: Language Arts

BACKGROUND: Water has been a popular topic in a variety of literary works from "Magic School Bus at the Water Works" to "Paddle to the Sea." Students can explore their water consumption habits by creating a *haiku* on an aspect of using water.

Developed in Japan at the turn of the century, *haiku* are unrhymed verse having three lines. The first line usually contains 5 syllables, the second line contains 7 syllables and the final line contains 5 syllables.

ACTIVITY:
1. Have students read the poem, "The Wonders of Water" which is on page 9 of *Hetch Hetchy's Water Magic*.

2. Brainstorm with students on different aspects of Raindrop's journey, such as joining a river, leaping over the water fall, swirling over river rocks, entering the filter pan and riding the water mains.

3. Have them create a *haiku* about the poem or create a *haiku* about an aspect of using water. You will need to tell the students that *haiku* is an unrhymed poem that has three lines containing 5, 7, and 5 syllables, respectively. An example would be:

   The fog floats seaward.
   As the moon rises, it seeks
   To find the City.

   Use water wisely.
   All things need water to live.
   Water for all.

DISCUSSION QUESTIONS:
1. How did you decide on the subject of your *haiku*?

2. Which images in your *haiku* are the most vivid? Which images do you like the best?

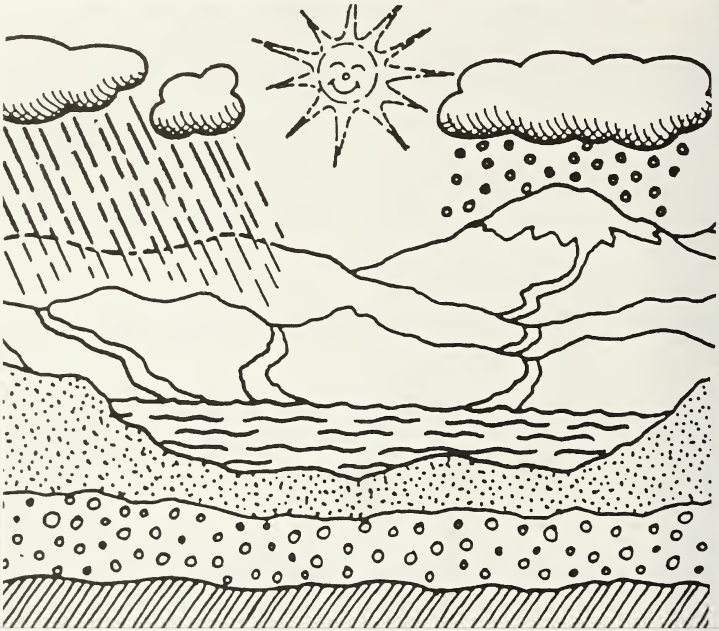
3. What topics did other students explore? Which topic(s) were repeated by the most number of students? Why?

EXTENSION:
4. Review the three forms of water with the class. Let the children work in pairs or small study groups and go through the poem on page 9 in *Hetch Hetchy's Water Magic* on page 9 to label the different forms of water being described with an L, S, or G for liquid, solid, or gas.

VOCABULARY: Umbrella, Moisture, Sleet, Hail, Aqueducts, Icicles, Marsh

Lesson 8 Activity Worksheet	Earth, A Natural Filter

Name: _____ Date: _____



This is a picture of how water is "cleaned" by the layers of earth. Illustrate how the earth filters the water through the sand and rocks.

When it rains, water falls to the earth. It filters down through the layers of earth and it becomes "naturally" cleaner. It may be stored as groundwater between layers of rock and sand.

Lesson 9 — Waste Busters

OBJECTIVE: Students compare their daily average water consumption with classmates.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, pg. 14

MATERIALS:
- Student workbook, page 14
- Student worksheet, pg. 20 of "Teacher's Guide"

FRAMEWORK: Earth Science B-4

BACKGROUND: The average person in San Francisco uses 70 gallons per day. This includes cooking, cleaning, showering and other water uses around the home. The largest amount (40%) of a person's daily water use is in flushing the toilet.

Because most homes and apartment buildings in San Francisco do not have large irrigated areas, San Franciscans tend to use less water than their counterparts in Sacramento, Los Angeles and other Californian cities. The average consumption per person in Los Angeles is 212 gallons per day. Approximately 50-60% of this water is used in outdoor irrigation.

Water agencies use per capita consumption figures as a guide on how much water is used per household. For example if a customer calls up and complains about a high water bill, the Water Department clerk will look at the daily consumption of the account and see if that amount has changed from the previous year. If the amount has dramatically increased from their last water bill, the customer can request an inspection for a large water leak.

ACTIVITY:
1. Brainstorm with the class how people, animals and plants use water. To get the class started, you should list all of the ways that you as an individual use water on a daily and weekly basis.

2. Have students figure out the number of times that they use water at both home and in school in an average day on the exercise in *Hetch Hetchy's Water Magic*, page 14.

3. If your students have multiplication skills, they can also complete the exercise sheet on the next page of this teachers' guide. With this exercise sheet, they can figure out how much water they use when they brush their teeth with the water running down the drain. They can also figure how much water they use when they brush their teeth without water running down the drain. The exercise sheet on the following page can help them figure out this useful information.

DISCUSSION QUESTIONS:
1. Why is it so important to use water wisely?

2. How many gallons do you think that the average person in San Francisco uses per day? (The average person in San Francisco uses 70 gallons per day.)

3. What ways can people reduce the water that they use in their own homes? How much water do you think that you can save?

Bath:	36 gal (full tub)
	15 gal (low-level in tub)
Shower:	37.5 gal (water running)
	5 gal ("Navy Style"— Soap, then rinse)
Toilet:	3.5 gal (average)
	1.6 gal (low-flow)
Washing hands:	2 gal (water running)
	1/2 gal (sink half-full)
Brushing teeth:	3 gal (water running)
	1 pint (wet brush; turn off)
Washing clothes:	50 gal/load
Dishes by hand:	45 gal (tap running)
	5 gal (rinse in basin)
Watering outside:	10 gal a minute (by hand)

VOCABULARY: Faucet, Low-Flow, Shade, Sprinkler, Hose, Toilet, Shower

Lesson 9 Activity Worksheet	Waste Busters

Name: _____ Date: _____

Use this worksheet to calculate the amount of water you use at home and school per day and the amount of water that your family uses per day. Mark the proper space with a check for each time you use water.

Using Water at Home	Gallons Per Use	No. of Times Used Per Day	No. of People in Family	Total Gallons Used Per Day
Sample-Taking a bath	36	1	3	36 x 3 x 1 = 124
Taking a bath	36			
Taking a shower	25			
Flushing a Toilet	3.5			
Washing hands or face	2			
Getting a drink	2			
Brushing your teeth	3			
Washing clothes	50			
Watering outside	30			
Using a dishwasher	30			
Washing dishes by Hand	45			
Other				

Using Water at School	Gallons Per Use	No. of Times Per Day	
Washing hands or face	2		
Flushing a toilet	3.5		
Getting a drink	2		
Other			

Lesson 10 — Storm Water Runoff

OBJECTIVE: Students learn about the impact of household hazardous waste such as oil and paint on the water quality of storm water runoff and sewage.

TIME: 2 class periods

FRAMEWORK: Earth Science B-4, C-4; Life Sci. A-4, C-4

MATERIALS:
- Watercolor supplies for all of the students in packet
- Two 11 by 17" pieces of paper per group of 4 students
- Push pins to hang paintings in packet
- Paint brushes in packet
- 5 cans to mix colors and clean brushes
- Access to water

CURRICULUM: Art

BACKGROUND: In San Francisco, we have a combined sewer and storm water runoff system. Sewage is everything that we pour down the drain or flush down the toilet in our homes, buildings and schools. Storm water runoff can be rain that runs into our sewers or water runoff from overwatering of landscaped areas. Since storm water runoff flows down streets and sidewalks before it enters our combined sewer/storm water system, it picks up oils and debris that are in the gutters, sidewalks or streets.

The sewage is treated in the following manner. Incoming sewage flows through bar screens that remove rags, sticks and other solids, which are scrapped off and trucked to a landfill. Next, heavy gritty materials like sand, egg shells and coffee grounds are removed. This also goes to a landfill.

Sewage is then pumped to primary settling tanks where it separates into wastewater and sludge. Grease is skimmed off the surface of the wastewater. After about two hours, the wastewater begins secondary treatment, flowing into aeration tanks where sewage-digesting bacteria, also known as activated sludge are added. Oxygen is bubbled through to speed up the bacteria into eating more sewage. After several hours, the wastewater flows to final settling tanks where it is held for up to three hours, allowing the bacteria to settle out. Floating material is skimmed once again. By this time, close to 90% of the pollutants are removed. The wastewater then goes through a chlorine disinfecting tank where sodium hypochlorite is added to kill germs, sodium bisulfite is added to remove the excess chlorine and finally the wastewater empties into the San Francisco Bay.

Meanwhile the solids removed from the wastewater are pumped into digestion tanks which are sealed and heated to 95 degrees Fahrenheit for 12 to 20 days. Inside, *anaerobic bacteria* (bacteria that do not need oxygen) break down the organic material into water, carbon dioxide and methane gas. The gas is pumped to run the boilers that provide heat to the plant. The rest of the gas is burned out. The digested sludge is dewatered and held in storage tanks. Finally, the sludge is hauled to a landfill, or recycled as fertilizer on agricultural land.

Oil, paint and other hazardous waste cannot be easily treated at the sewage treatment plant. In fact, they can sometimes kill a portion of aerobic bacteria as the hazardous wastes go through the sewage treatment plant. To avoid causing problems at the plant, the Department of Public Works regulates businesses who deal with motor oil, paint and other wastes. Instead of pouring these household wastes down the drain, the businesses dispose the materials with polymers, solutions and in environmentally-safe containers.

ACTIVITY:
1. Break students into groups of four. Using water colors, have each group create a painting of the San Francisco bay. Their picture should include people enjoying the bay, fish swimming in the bay and wildlife using the bay. Have students put the water they used to mix the colors and clean the brushes into the five cans.

2. Then have the groups create a second painting of the San Francisco Bay, but they have to use the five cans that they used to clean their brushes in the previous painting. So the paints are mixed with the dirty water and the colors become muted by the dirty water.

3. Once the paintings are dried, hang them up for comparison purposes.

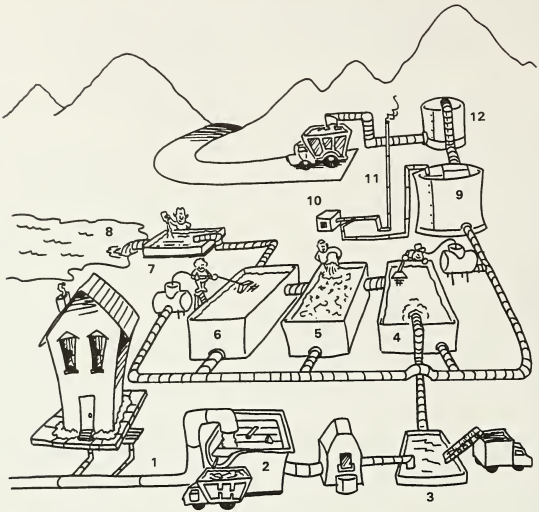
DISCUSSION:
1. What was the difference in colors between the first painting and the second painting? (The first painting should have clearer colors than the second painting. Clearness of water is defined by water chemists as clarity.)

2. What do you think happens to the fish that swim in water that is covered with oil? (Oil on the water can get on the fish gills; fish then die from suffocation.)

3. What can you and your family do to reduce toxins from getting into the storm water runoff? (You can make sure that oil, gasoline, cans and other debris do not get left on the ground or in the gutters.)

VOCABULARY: Hazardous household waste, Street sewers, Sink, Wastewater, Paint and oil

Sewage Treatment



Sewage Treatment

Incoming sewage **1** flows through bar screens **2** that removes rags, sticks and other garbage, which is scraped off and trucked to a landfill. Next, heavy gritty materials **3** like sand, egg shells and coffee grounds are removed and taken to a landfill. Sewage is then pumped to primary settling tanks **4** where it separates into wastewater and sludge. Grease is skimmed off the surface of the wastewater. After about two hours, the wastewater begins secondary treatment, flowing into aeration tanks **5** where sewage-digesting bacteria, also known as activated sludge, are added. Oxygen is bubbled through to speed up the bacteria's digestion of the sewage. After several hours, the wastewater flows to final settling tanks **6** where it is held for up to three hours allowing the bacteria to settle out. Floating material is skimmed once again. By this time, close to 90% of the pollutants are removed. The wastewater then goes through a chlorine disinfecting tank **7** where sodium hypochlorite is added to kill germs, sodium bisulfite is added to remove the excess chlorine and finally the wastewater empties into the San Francisco Bay.**8**

Meanwhile, the solids removed from the wastewater are pumped into digestion tanks **9** which are sealed and heated to 95° F for 12 to 20 days. Inside, anaerobic (no oxygen) bacteria break the organic material down into water, carbon dioxide and methane gas. The gas is pumped to run the boilers **10** that provide heat to the plant. The rest of the gas is burned off. **11** The digested sludge is dewatered and held in storage tanks. **12** Finally, the sludge is hauled to a landfill or is recycled as fertilizer on agricultural land.

Lesson 11 — Suds: Hard and Soft Water

OBJECTIVE: Students predict, observe and draw conclusions about the amount of suds produced by hard and soft water.

TIME: 1 class period

FRAMEWORK REFERENCE: Physical Sciences; Matter A-1

RESOURCE: *Hetch Hetchy's Water Magic*, pg. 17

BACKGROUND: Pure water is rare. Water usually contains calcium or magnesium in addition to two parts hydrogen and one part of oxygen. If water has a large concentration of calcium and magnesium, it is called **Hard Water. Soft Water** doesn't contain a high concentration of calcium and magnesium. Water naturally picks up these minerals as it filters through the earth and accumulates as groundwater or as it flows over rocks in streams and rivers. Calcium and magnesium in hard water interfere with the ability of the detergent to lower the surface tension of the water. A softer water allows water molecules to stretch and penetrate the soiled clothing more completely. Softer water also produces more suds.

Because San Francisco's water runs off granite rocks, it does not have many minerals. It is considered very soft. In fact, many companies like using our water because it is so soft, to process microchips and other computer components.

MATERIALS:

- 2 liters of tap water
- 2 liters of tap water mixed with one cup of salt
- 2 liters of distilled water in the packet
- 2 liters of mineral water in the packet
- 4 containers per group of four students (i.e. sandwich bags with self-enclosing closures or baby food jars with lids) in the packet
- 4 medicine droppers (one for each sample) in the packet
- 12 oz. of liquid dish washing detergent in the packet
- 4 – 8 oz. plastic cups in the packet
- Ruler for each group
- One measuring cup per four students in the packet

ACTIVITY:

1. Divide the class into lab groups of 4 students. Explain to students that pure water is rare. Water usually contains calcium and magnesium. In this experiment, students will find out which water sample has the highest concentration of calcium and magnesium. Review the instructions for the experiment on page 17 of *Hetch Hetchy's Water Magic*. Have them discuss the information they have been provided. Each group then records its prediction.

2. Have students set up four experiment areas one for each sample. Each area should include one sample, enough bags for each group to take a sample, a cup with 3 oz. of liquid detergent and an eyedropper.

3. Then have each group go to a different experiment area. At the experiment area, the group should do the following:

   a. Put 1/8 cup of water into the sample bag.
   b. Put three drops of water from the eyedropper into the bag.
   c. After the bag has been sealed or the lid has been screwed on, students should take turns shaking the sample for **five** minutes.

4. At each table, each group records the name of the water sample, a picture of the results and the height (number of inches) of the suds that was found after shaking each sample for five minutes. Hard water (which contains a high concentration of calcium and magnesium) will yield less suds than soft water (which contains a low concentration of calcium and magnesium).

5. Students will find that distilled water will have high suds because it does not have a high concentration of calcium and magnesium. When they distill water, they boil the water until it evaporates. The water vapor is then trapped and cooled. Distilled water results when the vapor is cooled and becomes a liquid. For the same reason, distilled water and SFWD's water will probably also yield high suds. Results from the tap water will depend upon its source. Water from Oakland, Alameda and Fremont will have less suds than water samples from San Francisco, Palo Alto, Daly City and South San Francisco. Palo Alto, Daly City and South San Francisco are wholesale customers of the San Francisco Water Department. Salty water and mineral water will yield a smaller number of suds because these contain magnesium and calcium.)

VOCABULARY: Detergent, Sample, Quantity, Prediction, Observations, Conclusions, Experiment, Minerals

Lesson 12 — All the Water Use Under the Sun

OBJECTIVE: Students will comprehend the need for water conservation in every aspect of their life.

TIME: 1 class period

RESOURCE: *Hetch Hetchy's Water Magic*, pg. 19

FRAMEWORK REFERENCE:

BACKGROUND: Water is a critical component for life—human life, animal life and plant life. Water is a limited resource. Even though the amount of water on the surface of the earth has always remained the same, the need and the distribution of water has not remained the same.

In many countries, families must walk two or three miles to a well to get their water. Because this involves a great deal of time, the younger members of the family are usually responsible for gathering water. Since a gallon of water weighs 8.34 pounds, full water containers can become heavy for people to carry back for a length of two to three miles.

MATERIALS:
- Piece of paper per student
- Pencil or pen per student

ACTIVITY:
1. Have students make a list of ten people that they know.
2. Have students make a list of ten animals that they know.
3. Have students make a list of ten plants that they know.
4. Then have students circle everything on their list that *does not* use water.
5. Brainstorm with students on ways that they and others can conserve water.

DISCUSSION:
1. What plants, animals or people don't use water? (Some of the animals and plants that might be identified are gerbils, camels and many types of fungus. The animals get their water from the foods that they eat.)
2. What ways can people save water?
3. Who can think of the biggest way to save water?

VOCABULARY: Habits, Animal, Resource, Rainbow, Sky, Apartment, Complete

Lesson 12 Activity Worksheet	All the Water Use Under the Sun

Name: _____ **Date:** _____

A. Make a list of 10 people whom you know.

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

B. Make a list of 10 animals.

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

C. Make a list of 10 plants.

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

Circle all of the plants, animals and people that DON'T USE water.

Water Bibliography

Non-fiction:

Drip Drop: Water's Journey; (2–6); Stwertka, 1991; detailed line drawings; basic properties of water; text is fairly technical in some chapters; covers the water cycle; how water is treated and piped to and from the home; methods of cleaning dirty water; conservation; valuable background on filtration process.

Facts on Water, Wind and Solar Power; (3–8); Watts, Franklin; Aladdin Books, New York, 1990, a beautifully illustrated 32-page book with outstanding color photos; useful information on water power (water wheels, dams, turbines and tidal power); excellent for teacher background material.

Follow the Water from Brook to Ocean; (K–4); Dorros, Arthur; Harper Collins, 1991; color illustrations; simple text and appealing watercolor art; explores water's journey overland to the sea; erosion; emphasizes keeping water clean.

New Water Book, The;(2–6); Berger, Belvin; Thomas Crowell Co., New York, 1973; illustrated for young children; includes the properties of water; water pollution, and many useful and simple experiments.

Oceans; (2–6); Simon, Seymour; Morrow Junior Books, New York, 1990; shows students with beautiful photos key facts about oceans, including ridges, ocean currents, wave energy and beach erosion.

Science Book of Water, The;(K–6); Ardley, Neil; Harcourt Brace Jovanovich, New York, 1991; excellent color photo illustrations; fun and easy experiments; basic information on water, explained in simple terms.

Survival at Sea; (4–6); Landsman, Susan; Avon Books, New York, 1993; gives student practical advice on what they would need to do if they were shipwrecked on a deserted island.

Water for Dinosaurs and You; (K–3); Gans, Roma, Crowell Publishers, New York, 1972; partial color illustrations; a description of water cycles, water pollution and information on protecting our water supply; simple, effective explanations and excellent illustrations; a Let's-Find-Out Science Book.

Water; (3–6); Michel, Francois; Lothrop, Lee and Shepard, New York, 1993; hands-on book about water, water treatment and water throughout our lives. By pulling flaps and tabs, students can climb up a waterfall, explore ocean tides and more.

Water's Way; (K–3); Peters, Lisa, Arcade Books, New York, 1991; gorgeous color illustrations by portrait and landscape artist Ted Rand; an imaginative and realistic portrayal of a boy's weather watching in order to use his new sled; it shows water from rain and snow to steam and fog.

Water, What It is, What It Does; (K–4); Seixas, Judith; Greenwillow Books, New York, 1987; an excellent overview of the subject of water told in simple terms with clever two-color illustrations.

Fiction:

Magic School Bus at the Waterworks, The; (K–3); Cole, Joanna; Scholastic, Inc., New York, c.1986; outstanding color illustrations; a fanciful story of a field trip to a local reservoir and water treatment plant.

Paddle to the Sea; (3–6); Holling, Clancy; Houghton Mifflin Co., Boston, c. 1969; color illustrations; a small canoe carved by an Indian boy makes a journey from Lake Superior to the Atlantic Ocean; includes adventures involving rivers, lakes, marshes, sawmills, beaver ponds and open sea; a Caldecott Honor Book.

Additional Resources

Videotape Reviews:

Down the Drain. Children's Television Workshop, New York, 1991; K–6; a 30-minute extra from the award-winning science series "3-2-1 Contact." Host Stephanie Yu explains how we get our water, where it goes after we use it, and how we get it clean. Excellent, entertaining and informative.

Hetch Hetchy and You. San Francisco Water Department and Bay Area Water Users Association, San Francisco, 1990; 16 minutes; grade 2 to adult; beautiful cinematography tracing the source of our water from the high Sierras; emphasizes the purity of Hetch Hetchy water; shows the magnificent O'Shaughnessy Dam and Hetch Hetchy Reservoir; excellent for teacher background and older students.

Secrets of the Bay. San Francisco Bay Association, 1990; 28 minutes; narrated by Jan Yanehiro; covers wildlife, pollution, overdevelopment, vanishing species, changes in the Delta, diversion of fresh water to farming; good teacher background.

Water Follies: a Soak Opera. Stan Philips and Associates, Hollywood, CA, 1987; 7 minutes; K–adult; uses animation; no dialogue; whimsically demonstrates and compares effective and wasteful uses of water; contains a brief conservation message at the end.

Notes

Evaluation Sheet

Name _____ School _____

As an educator of fourth through sixth grade students, your opinion is important to the San Francisco Water Department. SFWD needs your input about this book and other resources that you would find helpful in teaching your students about water and water conservation.

Please take a few moments to fill out this evaluation form and send it back to: SFWD, Attention: Conservation Unit, 425 Mason Street, San Francisco, CA 94102. **IN EXCHANGE FOR YOUR OPINION, WE WILL SEND YOU A FREE MAP FROM THE WATER EDUCATION FOUNDATION OR A SIMILAR TEACHING RESOURCE FOR USE IN YOUR CLASSROOM.**

1. Which lesson(s) in the Teachers' Guide to *Hetch Hetchy's Water Magic* did you use with your students? (Please circle all that are applicable)

1-The Magic of Water	7-Counting on Nature
2-States of Water	8-Earth, A Natural Filter
3-Water for SF	9-Waste Busters
4-How Dams Help Us	10-Storm Water Runoff
5-Eco-System of a River	11-Suds: Hard and Soft Water
6-How Tanks Help Us	12-All the Water Use Under the Sun

2. Which lesson(s) in the Teachers' Guide to *Hetch Hetchy's Water Magic* did **not** you find helpful in meeting the needs of your students and curriculum needs?

1-The Magic of Water	7-Counting on Nature
2-States of Water	8-Earth, A Natural Filter
3-Water for SF	9-Waste Busters
4-How Dams Help Us	10-Storm Water Runoff
5-Eco-System of a River	11-Suds: Hard and Soft Water
6-How Tanks Help Us	12-All the Water Use Under the Sun

3. What resources did you find helpful in the *Hetch Hetchy's Water Magic* curriculum packet? (Please circle all that are applicable)

   Teacher's Guide
   California Water Resources Map
   Map of San Francisco's Water System
   Map of Hetch Hetchy
   Map of the State of California
   Bibliography of Student Books on Water

4. Do you have any comments on what would have made this resource packet more useful for you and your students?

   _____

   _____

   _____

Please return or fax this evaluation form to: **San Francisco Water Department, Attention: Conservation Unit, 425 Mason Street, San Francisco, CA 94102. The fax number is 415–771–4421 and the phone number is 415–923–2571.**

More Space for Your Comments

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